CHAPTER 4

HOUSING DESIGN AND LAYOUT

4.1 INTRODUCTION

This chapter discusses housing design and requirements for air cleaning units in which filters and/or adsorbers are installed. Two basic designs are addressed in this section: man-entry (**FIGURE 4.1**) and side-access. In addition, two side-access housing types are addressed—one utilizing square filters (**FIGURE 4.2**) the other radial flow/round filters (**FIGURE 4.3**). Both designs are for housings with two or more filters and for system capacities greater than 2,000 cfm. Single-filter in-line housings, man-entry housings larger than 30 high-efficiency particulate air (HEPA) filters, and masonry/concrete housings are not considered here.

4.2 HOUSING SYSTEM DESIGN

Large-volume air supply and exhaust requirements may be met by a number of side-access or man-entry filter housing installations operating in parallel or in a single central system. Parallel housings have the advantages

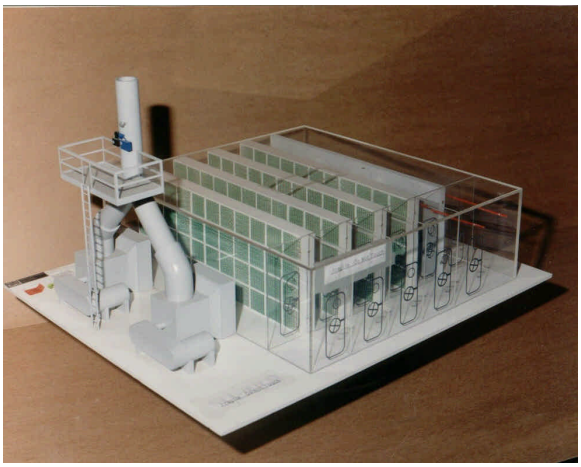

Figure 4.1 – Model of a man entry plenum

Figure 4.2 – Side-access design (square filter)

of (1) greater flexibility for system modification; (2) minimum interference with operations during filter replacement because individual units can be shut down without affecting the remaining systems; (3) good overall ventilation control in the event of malfunction, fire, or accident to one or a few individual units; and (4) easy system testing and balancing.

4.2.1 MAN ENTRY HOUSING SYSTEM DESIGN

A number of open-face filters are installed in parallel on a single mounting frame in a single-housing filter bank design. Filter banks are the more common type of large, multiple-filter installation, but banks larger than 30,000-cfm nominal capacity (i.e., thirty 1,000-cfm filters) are no longer recommended for nuclear exhaust or cleanup service because of difficulties in control, maintenance, and testing. For exhaust and cleanup systems larger than 30,000-cfm capacity, segmentation of the system into two or more parts of equal airflow capacity, with each part in a housing installed in parallel, is recommended. Isolation valves on each housing

Figure 4.3 – Side-access design (Radial Filters)

are desirable for convenient system control, isolation of individual units during an emergency, and maintenance or testing activities.

4.2.2 ARRANGEMENT AND LOCATION

Maintainability is a major consideration when laying out filter housings. Although some systems may have only a single bank of HEPA filters, most will have at least an additional bank of prefilters, and many will have multiple banks of HEPA filters. Those systems in which radioiodine releases must be controlled will also require one or more banks of adsorbers. Often a bank of demisters is required, resulting in as many as six or more banks of components in a single housing. There must be sufficient clear corridor space adjacent to the housing for handling filters during filter changes, as well as adequate corridors to and from the housing. Dollies are often used to transport filters to and from the housing area. This practice results in safer operations that reduce the risk of both injury to personnel and spread of contamination from dropped filters. When dollies are used, space is required to move the dollies in and out and for loading and unloading. Additional space is desirable for stacking new filters (in their cartons) adjacent to the work area during the filter change-out process. Recommended clearances for housings and adjacent aisles or air locks are given in **FIGURE 4.4**.

Proper access to the filter housing is sometimes overlooked. Too frequently, housings are situated among machinery, equipment, and ductwork where workmen are required to climb between, over, or under obstructions to get to the housing door, where they still have inadequate work space. In some installations, it is necessary to carry filters one at a time over ductwork and then rely on rope slings to transfer

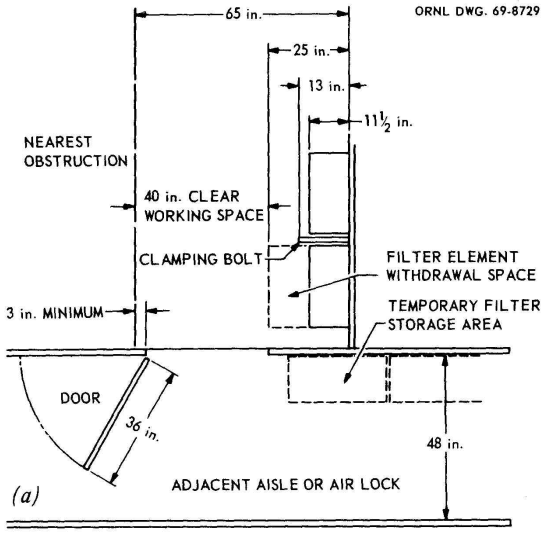

Figure 4.4 – Recommended clearances for housings

them up to the floor above where the air cleaning system is located. It is essential to preplan the route for getting filters and adsorbers to and from the housing and to provide elevators or cranes where they have to be hoisted to an upper level. Gallery stairways are also recommended in lieu of ladders. See **FIGURES 4.5 through 4.14**.

Figure 4.5 – Airlock entry for man-entry plenum. Filters are to allow pressure equalization

Figure 4.7 – Man-entry plenum (lower level), looking at mist eliminator upstream side of first HEPA filter stage

Figure 4.6 – Man-entry plenum ship doors into airlock

Figure 4.8 – Manentry plenum. Upper level looking at upstream side of 1st HEPA filter stage

Figure 4.9 – Man-entry filter plenum

Figure 4.10 – Man-entry plenum looking at a ship door between HEPA filter stages

Figure 4.11 – Common AILE between two-man-entry plenums

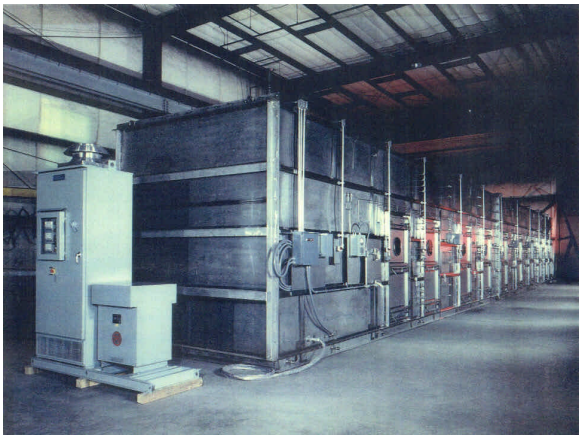

Figure 4.12 – Chemical demilitarization filter

Figure 4.13 – Control room pressurizing air filter

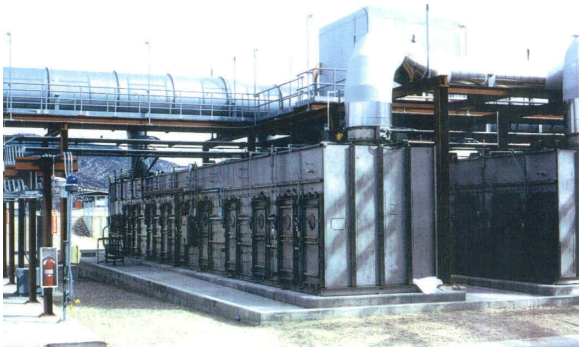

Figure 4.14 – Munition demilitarization building exhaust filter system

High-risk operations often require segmented systems with two or more housings ducted in parallel that exhaust from the same area and vent to the same stack. Each housing must have inlet and outlet isolation dampers to permit one to be held in standby or, when both are normally operated simultaneously, to allow one housing to be shut down for maintenance, testing, and emergencies.

Another important consideration in housing layout is uniformity of airflow through the installed components. This is especially important for adsorbers, since flow through those components must achieve the gas residence time required for efficient adsorption of radioactive organic iodine compounds. For large, multiple-filter housings that must operate in parallel, equalizing screens may be required in each filter unit to ensure uniform flow in housings. Long transitions are difficult, particularly in large housings. Nevertheless, every effort should be made to locate and design inlets and outlets to avoid stratification and to enhance the uniformity of airflow through components.

Special care must be taken in designing side-access housings to ensure uniform flow through all filter elements. It is recommended that manufacturers performance-test prototype side-access filter units in accordance with ASME AG-1, Section TA,[26] to document uniformity of flow through side-access filter units before fabrication of production units. When high-activity alpha-emitters such as plutonium or transuranic elements are handled, it may also be desirable to compartment the system both in series, with separate housings for prefilters and HEPA filters, and in parallel for extra safety.

4.3 COMPONENT INSTALLATION

4.3.1 GENERAL

Proper installation of HEPA filters, adsorber cells, and demisters are critical to the reliable operation of a high-efficiency air cleaning system. HEPA filter and adsorber frames should be designed in accordance with the requirements of ASME AG-1, Section FG.[25]

4.3.2 CONSIDERATIONS

Factors that must be considered in designing such installations include:

- Structural rigidity of mounting frames
- Rigid and positive clamping of components to the mounting frame
- Careful specification of and strict adherence to close tolerances on alignment, flatness, and the surface condition of component seating surfaces
- Welded-frame construction and the welded seal between the mounting frame and housing
- Ability to inspect the interface between components and the mounting frame during installation (man-entry)
- Adequate spacing between components in the bank (man-entry)
- Adequate spacing in the housing for men to work (man-entry).

4.3.3 HOUSING CONSTRUCTION

The components and mounting frame should form a continuous barrier between the contaminated and clean zones of the system. Any hole, crack, or defect in the mounting frame or in the seal between components and the frame that permits bypassing will result in leakage of contaminated air into the clean zone and reduced system effectiveness. A mounting frame that is not sufficiently rigid can flex so much during